Claims

What is claimed is:

1. An embossed oriented film comprising:

an optically transparent, anisotropic, uniaxially oriented thermoplastic polymer film having a first major surface and a second major surface;

an embossed pattern on the first major surface of the thermoplastic polymer film comprising a plurality of parallel microchannels having a longitudinal direction substantially parallel to the direction of orientation of the polymer film;

wherein the orientation of the embossed film is substantially the same in the bulk and at the surface as that of uniaxially oriented polymer film prior to embossing.

2. The embossed oriented film of claim 1 wherein the thermoplastic film comprises a semi-crystalline thermoplastic polymer.

3. The embossed oriented film of claim 1 wherein the thermoplastic film comprises an amorphous glassy thermoplastic polymer.

4. The embossed oriented film of claim 1 wherein the pattern comprises a plurality of v-shaped grooves.

5. The embossed oriented film of claim 4 wherein the width of the grooves is between 0.2 microns to 500 microns.

6. The embossed oriented film of claim 4 wherein the distance between the grooves is between 0.2 microns to 500 microns.

7. The embossed oriented film of claim 1 further comprising an isotropic coating overlying the embossed pattern on the first major surface of the anisotropic film.

8. The embossed oriented film of claim 1 further comprising an adhesive layer adhered to the second major surface of the anisotropic film.

9. The embossed oriented film of claim 1 wherein the uniaxially oriented thermoplastic film is a birefringent film having a birefringence in the range of 0.1 to 0.5.

10. The embossed oriented film of claim 1 wherein the thermoplastic film comprises polyethylene naphthalate.

11. A method of making an embossed optical sheet material comprising:

providing an optically anisotropic, uniaxially oriented polymer substrate having a first major surface and a second major surface;

heating a patterned tool using radiant energy from a radiant energy source, wherein the pattern comprises a plurality of parallel raised microstructures having a longitudinal direction;

pressing the tool against the first major surface of the polymer substrate such that the longitudinal direction of the raised microstructures is substantially parallel to the direction of orientation of the polymer substrate, to soften the first major surface of the polymer substrate and emboss groove-shaped microchannels into the polymer substrate;

cooling the embossed polymer substrate;

separating the tool from the polymer substrate;

wherein the orientation of the polymer substrate is unchanged throughout the polymer substrate and first major surface.

12. The method of claim 11 wherein the uniaxially oriented polymer substrate is a birefringent film having a birefringence in the range of 0.1 to 0.5.

13. The method of claim 11 wherein the polymer substrate comprises a semi-crystalline thermoplastic polymer.

14. The method of claim 11 wherein the polymer substrate comprises an amorphous glassy thermoplastic polymer.

15. The method of claim 11, wherein the radiantly heating, the pressing, and the separating, are all performed as parts of a roll-to-roll process.

16. The method of claim 15, wherein the tool is part of a patterned belt that includes a patterned tool surface and a flexible backing.

17. The method of claim 16, wherein the flexible backing is thermally insulative relative to the patterned tool surface.

18. The method of claim 17, wherein the patterned tool surface includes a metallic surface.

19. The method of claim 18, wherein the metallic surface includes a nickel surface.

20. The method of claim 11, wherein the patterned tool surface includes a metallic surface.

21. The method of claim 20, wherein the metallic surface includes a nickel surface.

22. The method of claim 20, wherein the metallic surface is backed with a relatively thermally insulative material.

23. The method of claim 11, wherein the patterned tool surface includes a nonmetallic surface.

24. The method of claim 23, wherein the nonmetallic surface includes a semiconductor surface.

25. The method of claim 23, wherein the nonmetallic surface is backed with a relatively thermally insulative material.

26. The method of claim 11, wherein the pressing the patterned tool against the sheet commences after the radiantly heating.

27. The method of claim 11, wherein the radiant energy from the radiant energy source has most of its energy in a wavelength range of between 0.4 to 2 μm (microns).

28. The method of claim 11, wherein the radiant energy source includes a blackbody emitter.

29. The method of claim 28, wherein the blackbody emitter has a temperature of at least 2000 K.

30. The method of claim 28, wherein the blackbody emitter has a temperature of at least 3000 K.

31. The method of claim 28, wherein the blackbody emitter has a temperature of about 3200 K.

32. The method of claim 11, further including passing the radiant energy through a relatively radiantly transparent roller.

33. The method of claim 32, wherein the passing the energy through the roller includes focusing the radiant energy.